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JORDAN TOURISM DEVELOPMENT PROJECT II (SIYAHA II)

**DEPLOYMENT OF A SHUTTLE SYSTEM ON THE TURKMANIYYA ROAD
A PAPER ON VEHICULAR OPTIONS
PETRA ARCHAEOLOGICAL PARK
MARCH 2010
FINAL**

March 2010

This publication was produced for review by the United States Agency for International Development. It was prepared by Chemonics International Inc.

JORDAN TOURISM DEVELOPMENT PROJECT II (SIYAHA II)

**22170 DEPLOYMENT OF A SHUTTLE SYSTEM ON THE TURKMANIYYA
ROAD**

GBTI Contract No. EPP-I-00-06-00013-00
Task Order No. EPP-I-02-06-00013-00

This publication was produced by the USAID/Jordan Tourism Development Project II, under the direction of Ibrahim Osta, Chief of Party.

The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

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ANNEX 1 Proposed Turkmaniyya Road Electric Shuttle Service – Petra

ACRONYMS

PDTRA	Petra Development and Tourism Regional Authority
JDTP II	Jordan Tourism Development Project II
UNESCO	United Nations Educational, Scientific, and Cultural Organization
USAID	United States Agency for International Development

1. EXECUTIVE SUMMARY

For almost two decades, the issue of an alternative exit to the Petra Archaeological Park has been the subject of discussion, planning recommendations and some proactive endeavors. The Ministry of Tourism and Antiquities' construction of the Turkmaniyya Road in the 90's significantly moved forward the physical prospect of this as a formalized, alternate park route.

The USAID/Jordan Tourism Development Project II (Siyaha II) was requested by the Petra Development and Tourism Region Authority (PDTRA) to assess viable vehicle transportation options, for deployment of a shuttle system on the Turkmaniyya Road to convey visitors from a point near the basin to the visitor center through the Um Sayhoun village.

The objective of Siyaha II assignment is to conduct an initial assessment of the available vehicular options that maybe considered and further explored by the PDTRA, to operate within the Petra Archaeological Park environment. A team comprised of a transportation expert, an environmentalist, an archaeologist, an architect and a conservation specialist considered a variety of parameters to identify these options taking into consideration the following: sensitivity of the archaeological park, environment, gradient of road and availability as well as suitability of engine and appropriate fuel types. The fragility of the site and its World Heritage status was an overriding concern in the review process.

The following section summarizes the various options reviewed, along with a narration on challenges, pros and cons of each option: Compressed Natural Gas (CNG), diesel, gasoline, propane and electric powered engines. Based on the initial consideration of the aforementioned parameters, the option of Compressed Natural Gas has been identified as the most viable option for PDTRA's further investigation. More detailed technical considerations are summarized in Section 3.

While this report and its Annexes provide findings of a potentially feasible option, this assessment provides guidance for further necessary assessments and, as a result, is not a recommendation for PDTRA to select a single option definitively. For any mechanized transportation system that PDTRA may opt to deploy, thorough and detailed studies are still needed to arrive at a final conclusion, as set out in Section 4.

2. AVAILABLE TRANSPORTATION OPTIONS AND OPERATION METHODS

Following initial assessments of consultants' research of key alternative methods of transport and fuel types, the table below summarizes the initial findings. In principle, the choice of vehicle engine type should be considered following a proper Environmental Impact Assessment is conducted clearing the chosen solution. Such a solution should be based on the suitability and availability of fuel options in Jordan that are sensitive to the fragility of Petra's monuments and its environment, including emission levels. This rapid assessment concludes that, absent future availability of suitable fuel supply, it is not currently possible to deploy an ideal transport vehicle engine type with low emissions, given the present challenges in fuel or technical issues.

Summary of Various Vehicle and Fuel Types

Vehicle Type I: Diesel Powered Vehicles		
Pros	Cons	Remarks
<ul style="list-style-type: none"> Cheap, immediately available No special modifications needed No special stations required Sufficient capacity to convey required load of tourists Enough power to handle the slope of the exit road. 	<ul style="list-style-type: none"> Unacceptable emissions levels (sulphur content 9000 ppm for Jordanian diesel vs. 500 in the USA) 	<p>Option rejected due to unacceptable emissions levels.</p>
Vehicle Type II: Gasoline powered vehicles		
Pros	Cons	Remarks
<ul style="list-style-type: none"> Cheap, can be ordered from all major manufacturers without any custom modifications No special stations required Sufficient capacity to convey required load of tourists Enough power to handle the slope of the exit road. 	<ul style="list-style-type: none"> Emissions levels (sulphur content 150 ppm for Jordanian gasoline vs. 80 in other countries) 	<ul style="list-style-type: none"> Needs further assessment by future Environmental Impact Assessment (EIA) studies. Needs to be cleared with UNESCO World Heritage Committee, and/or other environmental agencies for approval(s) pending EIA findings. Very possibly the only feasible option left when all others fail.
Vehicle Type III: Propane (LPG) powered vehicles		
Pros	Cons	Remarks
<ul style="list-style-type: none"> Acceptable levels of emissions likely to be approved by Heritage Sites guardians and specialized agencies. A marked reduction in pollution. Sufficient capacity to convey required load of tourists Powered to handle the slope of the exit road. 	<ul style="list-style-type: none"> Special (and expensive) compression and pumping stations required. Jordan propane mixture does not fit propane powered bus engine designs. Custom-made engines and vehicles. Training of operational staff required. Safety concerns about location of gas depot and transportation from source. Propane tanks need to be kept cool, which will be a challenge in the hot environment of Petra. Special cooling apparatus may be needed. 	<p>Option rejected due to:</p> <ul style="list-style-type: none"> Non-availability of Propane in Jordan as an alternative fuel. The physical attributes of Turkmaniyya Road (gradient of the road) The relatively high temperature in which the vehicles are required to operate LPG seems to be preferred over CNG by some manufacturers.

Vehicle Type IV: Electric powered vehicles		
Pros	Cons	Remarks
<ul style="list-style-type: none"> ▪ The best option due to no emissions ▪ Precedent setting at the international level 	<ul style="list-style-type: none"> ▪ Special charging stations required. ▪ Custom made engines and vehicles at a considerable cost. ▪ Not enough carrying capacity to convey required load of tourists at peak hours. ▪ Engines would not provide enough power to handle the extreme slope of the road. ▪ It seems that only a limited type of batteries presumably can deliver the required power, but only in theory. No actual precedents and verified performance certificates exist. ▪ Ambient heat over 30 degrees Celsius will diminish almost 50% of battery efficiency, which is the norm in most of the days at Petra renders this an unpractical option. 	<p>Option rejected due to:</p> <ul style="list-style-type: none"> ▪ Explored engines options are not strong enough to handle the slope; batteries cannot operate efficiently in summer heat. Low seating capacities cannot handle the volumes of visitors. ▪ Significant operations maintenance skill and diligence required.
Vehicle Type V: Compressed Natural Gas (CNG) powered vehicles		
Pros	Cons	Remarks
<ul style="list-style-type: none"> ▪ Acceptable levels of emissions likely to be approved by Heritage Sites committees. ▪ Very low particulate emissions. Low emissions of airborne toxins. Negligible SOx emissions. ▪ A marked reduction in pollution. ▪ Enough carrying capacity to convey required load of tourists ▪ Quieter operation, with less vibrations and reduction of odors in comparison with equivalent diesel engines. 	<ul style="list-style-type: none"> ▪ Special (and expensive) compression and pumping stations required. ▪ Custom made engines and vehicles. ▪ CNG availability at a reasonable cost needs to be determined. 	<p>The most viable option, yet with challenges that need to be overcome:</p> <ul style="list-style-type: none"> ▪ Needs further assessment via an EIA and other feasibility studies (<i>Care must be given to greenhouse effect when considering viability</i>). ▪ Needs further determination to ascertain engines are able to deliver enough power to handle the slope of the exit road. ▪ Availability of fuel via a pumping station suitable for vehicles needs to be established.

3. INITIAL RESEARCH ON MOST VIABLE OPTION: COMPRESSED NATURAL GAS (CNG)

Compressed Natural Gas (CNG) is an environmentally-friendly transport fuel option. To determine its availability, a meeting was held with the Executive Director of Jordan Petroleum Refinery Company who confirmed that Natural Gas is available for commercial use in Jordan. However, there remain logistical considerations associated with the supply, storage and transport of CNG to Petra. This initial finding warrants additional study to absolutely establish the viability of this option. Following is a summary of key issues:

3.1 Logistical considerations

Currently, Jordan imports CNG from Egypt transporting it through a major pipeline system. The supply of CNG is limited only to electricity generating stations in Jordan. According to the Ministry of Energy, there is no infrastructure network to supply CNG for commercial or residential use. The key impediment is the absence of fuel stations or transport system from the main Egypt/Jordan pipeline to other locations in Jordan.

In order to render this fuel type available for use in Petra, PDTRA may consider intra-governmental dialogue to:

- Learn from the Ministry of Energy and Minerals its intention and timing for the supply of CNG for commercial and residential use as advised by May 2005 feasibility study.
- Investigate the time required for infrastructure setup and supply of CNG by the Jordanian Egyptian Fajr for Natural Gas Transmission and Supply Co. Ltd.

3.2 Operational and capital costs considerations

- The incremental cost of a natural gas engine and associated equipment (gas cylinders, piping, valves etc) as compared to an equivalent Diesel engine. The purchase price of a Compressed Natural Gas powered buses is between 15 and 25% more than a typical petrol bus. According to the International Energy Agency (IEA), a CNG bus costs “US\$ 25,000 to 50,000 more than comparable diesel bus. The exact cost depends on bus size and type, competitive pricing among producers, and whether additional features are required.
- The cost related to the fueling infrastructure required for the use of compressed natural gas (CNG). Such infrastructure includes, but is not limited to, a compression station, a fuel station and associated pumping stations, and engineering work needed to supply the compression station from the main source.
- The operating and maintenance cost related to the use of natural gas vehicles as compared to gasoline.

3.3 Safety considerations

- The characteristics of natural gas, and the installation and structure of the fuel containers make it safer than conventional fuels in a crash situation or fire. The gas is non-toxic and naturally odorless (additives are required to add odor).
- As natural gas is less dense than air, in the event of a leakage, the gas will rise and disperse into the atmosphere.

- The diffusion coefficient of gas is high in comparison to conventional fuels; it therefore diffuses rapidly into the ambient air.
- The flammability limits of natural gas are narrow in comparison with conventional fuels, thus comparatively lowering the probability of fire.

The disadvantages of natural gas include the following:

- Greater difficulty in distribution and storage.
- Shorter driving range. CNG buses are between 17 % and 41% less fuel efficient than conventional diesel buses. CNG buses have a driving range of about 300 miles (depending upon the capacity of the gas cylinders) compared to a little more than 400 miles for diesel buses.
- Greater weight of the fuel tank (gas cylinder) when compared with a traditional diesel tank

4. WAY FORWARD - OVERALL PROJECT REQUIREMENTS

Given the sensitive geological, environmental, aesthetic, historic, archaeological and legal context of the Turkmaniyya Road, extensive assessment of the existing conditions is a prerequisite to evaluating the case for shuttle operations, and new park procedures. The following gives a summation of requisite research in the consideration of the Turkmaniyya Road exit proposition.

4.1 Engineering assessments & studies

A multi-disciplinary engineering firm should be commissioned by PDTRA to conduct detailed engineering studies, and as a first step towards validation of transportation model. This assessment would ideally be coordinated with the preparation of the environmental assessment requisites (see Section 4.4). PDTRA should develop a ToR that covers, but not limited to, the following work areas:

- Assessment of existing physical conditions of the road
- Recommendations on structural alterations for road and drainage options
- Assessment of proposed area for pick-up and drop off bus station at Um Sayhoun and its connectivity with its environs.
- Allocation of a service depot for shuttle buses operating on the road.
- Study of required parking spaces and building facilities at the proposed bus station.
- Verifying topographical surveys
- Recommendations on infrastructure requirements for road deployment and set-up of vehicle facilities
- Traffic and safety analysis (particularly on the main public road from Um-Syahoon to visitors' center). Study to include vehicular and passenger traffic in and around bus station and the connectivity of passengers back to main Visitor Center.
- Assessment of available utilities including water, electricity and other potential vehicle requisites and their provision adjacent to, or inside, PAP boundaries
- Development of work plan and project budget

4.2 BUSINESS MODEL AND APPROPRIATE PPP OPTION

PDTRA envisions that the shuttle system will be operated by the locals at Petra region, which is one form of Public Private Partnership (PPP) on site. The PPP models vary from short-term simple management contracts (with or without investment requirements) to long-term and very complex Built Operate and Transfer (BOT) forms. PDTRA should commission a specialized firm to conduct a study of suitable PPP model that goes through the following phases:

- Pre feasibility assessment and return on investment
- Preliminary clearance from the Government of Jordan
- Due diligence studies, including: technical, financial and legal aspects as well as setting performance standards and define service area (responsibility of operator vs. owner).
- Selection of Private Public Partnership model that is governed by the following criteria:
 - ✓ Ownership of capital assets
 - ✓ Responsibility for investment
 - ✓ Assumption of risks, and
 - ✓ Duration of contract
- Development of business and financial model for operations and maintenance
- Preparation of tender documents

Note: While it is envisioned by PDTRA that the project will be granted solely to the local population, it is strongly recommended to conduct a competitive bid to ensure acceptable services standards. However, the PDTRA can specify special conditions that necessitate that the private sector consortium allocates a minimum quota of local community shares.

4.3 ANALYSIS OF PARK VISITATION AND CIRCULATION

On the PAP Main Trail

It is reported by PDTRA management that visitor numbers continue to increase. The restricted means of entry and egress to the park is important to any exit project rationale (i.e. the number of visitors at one time in Al-Khazna has already exceeded the thresholds recommended by UNESCO and the USNPS). To be definitive, an assessment of site intensification and associated impacts of increased visitation is necessary. Analyses should include:

- Summary statistics for the past decade of site visitation, including as feasible, tourist origin, age group, type of traveler (i.e.: group or independent), visit date(s)
- Survey assessments of visitor numbers reaching each of the key park zones (i.e. distribution statistics have indicated that 95% reach Al-Khazna and only about 60% reach Qasr al-Bint / the Basin)
- Initiation of visitor impact monitoring surveys (see protocols set out in Siyaha US/ICOMOS Carrying Capacity Report 2009)
- Estimated current number of visitors using local services for donkeys, camels and horse carriages for visitor trips on the Main Trail.

Current Use of Turkmaniyya Road

It is known that there is active use of the Turkmaniyya Road by vendors, staff, tourism operators and service personnel. The following baseline survey is needed to establish current patterns and potential impact:

- Vehicle use (including number and type of engine, number of visitor or local occupants, load, etc.)
- Number of visitors walking or using donkey services to exit at Um Sayhoun.

4.4 ENVIRONMENTAL ASSESSMENT

It is understood that the objectives of this project call for the identification of a shuttle transport system that minimizes impacts to archaeology and nature, and utilize existing facilities with minimal requirements for new construction. Given the archaeological and natural resource importance and sensitivity, an EIA is a prerequisite and parallel to planning of a shuttle or alternate access route. In short, EIAs are conducted to prevent irreversible damage to natural and cultural sites, enabling decision makers with the means to cancel or mitigate infrastructure development likely to impact the physical and cultural resources.

As a UNESCO World Heritage Site, the EIA process is also expected as a part of the State Party endorsed international legal and treaty mandates to protect PAP's resources. In cooperation with their State Parties and responsible federal government institutions, World Heritage sites are periodically monitored for their condition and management. The Dresden Valley, Germany, was recently deleted from the World Heritage List as a result of a bridge construction project. It is relevant that the 1995 UNESCO Petra National Park Management Plan stated, "No transportation vehicle will be allowed into the Petra Sanctuary to ensure the respect of its integrity. This measure particularly concerns the existing paved winding road from Um Sayhoun to Central Petra", (p. 198). It is also noteworthy that PAP has undergone tremendous growth in tourism since the compilation of this report.

There is currently inadequate baseline datum to identify basic physical conditions in the Turkmaniyya vicinity, and this should commence including, for example:

- Survey of terrain and park boundary
- Inventory of architectural and archaeological resources
- Inventory of flora and vegetation
- Inventory of wildlife, livestock
- Air quality/conditions, dust
- Modern interventions (services, structures, etc.)
- Water resources, urban runoff and drainage
- Soil and erosion
- Human circulation and impacts (items noted in 4.1)
- View shed and visual assessments
- Current vehicular use and impacts.

With the baseline data, the assessment of the proposed future use(s) can proceed, including associated emission, economics, etc., including:

- Direct, indirect and cumulative impacts
- Socio-economic effects
- Structural options and/or requisites and any related construction generated impacts
- Potential operations related impacts.

In the EIA, consideration needs to be given to other options for exit or access in PAP, both routes and methods (i.e.: pedestrian, animal or vehicular transport).

As a part of this process, stakeholder group, government partner and public consultations are essential.